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EFFECT OF GEOGRAPHY ON THE EXTENSIVE AGRICULTURAL USE OF SEWAGE--ETC(U)
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EFFECT OF GEOGRAPHY ON THE EXTENSIVE AGRICULTURAL USE OF SEWAGE

(Wplyw Czynnika Geograficznego na Rozpowszechnienie Rolniczego Wykorzystania wod Sciekowych),

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This article considers the causes of the elimination of many irrigated fields in England when the development of this kind of arrangement was appearing in other countries. Unfavorable local and soil climatic conditions necessitated the replacement of irrigated fields by purification plants of another type. The liquidation of irrigated fields in England and in the Eastern United States should not be an example for countries in which other geographic conditions predominate. The considerable simultaneous increase in arrangements of

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THE EFFECT OF GEOGRAPHY ON THE EXTENSIVE AGRICULTURAL USE OF SEWAGE

(Wplyw czynnika geograficznego na rozpowszechnienie rolniczego wykorzystania wod sciekowych)

Jan Wierzbicki, Dr. Eng.

This article considers the causes of the elimination of many irrigated fields in England when the development of this kind of arrangement was appearing in other countries. Unfavorable local and soil climatic conditions necessitated the replacement of irrigated fields by purification plants of another type. The liquidation of irrigated fields in England and in the Eastern United States should not be an example for countries in which other geographic conditions predominate. The considerable simultaneous increase in arrangements of this type in other countries proves the incorrectness of uncritical copying of England's example and negative reaction to the agricultural use of sewage water in localities with conditions which favor its use.

The extensive use of sewage purification on flooded (irrigated) fields and the proper effect of such arrangements depend on local conditions; under unfavorable conditions even arrangements which have been in existence for many years are subject to gradual elimination. England can serve as an example of the improper use of this method in connection with a geographic factor.

The large amount of sewage associated with the rapid development of cities and the simultaneous desire of large areas of the population to preserve hygienic environmental conditions led to the development of sewers and purification. In the second half of the last century England was considerably ahead of other countries in the field of purifying urban sewage. During the period of the construction of the first purification plants on a major scale, these arrangements were particularly an example for other countries. They used the only method known at that time: purification on irrigated fields.

The conditions prevailing in England are not favorable for irrigated fields. Indeed, the mild climate which extends the vegetative period to 8 - 10 months (compared to 6 - 7 months in Poland) does favor the agricultural use of sewage, but other conditions indicate against the use of this kind of arrangement.

Argillaceous and lime soils predominate in England. Loam appears most often in river valleys. Heavy lime-clayey soils (marl) and fertile chalk fields are most widespread in the central and southern parts of the island, with heavy loam in the London area. A little lighter soil occurs on the eastern coast, but the light pasture soils, most appropriate for setting up irrigation fields, are not found in a sufficient area to set up fields of this type in the British Isles.

Because of the generally heavy soil, the many irrigated fields set up in England in the second half of the past century suffered from unfavorable conditions. Because of the insufficient permeability of the soil, it was necessary to use percolation on the sod surface (surface irrigation). Good

purification results, yielding good crops of grass at the same time, could be obtained only with a very small burden: the sewage from 50 inhabitants per hectare per year.

For the purpose of increasing the burden many cities drained the irrigated fields. In order to obtain better permeability on fields of heavy loam soil, the drains were filled with cinders, rubble, coarse sand and other materials of a similar nature, but this was given up because of the unsatisfactory sewage purification results. Some cities, with only turf soil at their disposal, set up irrigated fields on this type of soil. The results obtained were simply bad because of the minimal permeability of the swelling turf. In 1864 the Royal Commission issued a statement on the complete unsuitability of turf soil for purifying sewage.

In view of the considerably greater consumption of water by the inhabitants of English cities, sewage is more dilute in comparison with the sewage from the cities of Central Europe, and has a lower fertilizer value.

Water from the sewage of English cities as a factor of increasing crops is insignificant, and this is particularly due to the high relative humidity of the air:

March	79 - 80%
July	73 - 88%
September	80 - 88%
November	82 - 91%.

In addition the considerable amount of precipitation, an annual average of 1052 mm eliminates any need to use irrigation.

Another factor restricting the general agricultural use of sewage in England is the presence of compounds in the water which are harmful to plants. This is due to the great industrialization of the cities.

Conditions in Central Europe have developed completely differently. Thanks to the insufficient amount of precipitation in the vegetative period, the abundance of light, permeable soil, the large amount of fertilizer compounds in 1 m^3 of water[1] and the general complete suitability of sewage for irrigating agricultural crops, there has been a rapid development in the construction of irrigated fields. Just as in England, unfavorable conditions for using irrigated fields to purify sewage prevail in the eastern United States.

A considerable amount of precipitation (an average of about 1000 mm yearly), a predominantly rocky soil and a large amount of diluted sewage (an average of 300 l/day per inhabitant) have been factors decidedly unfavorable to the

[1] An average of 90 g of total nitrogen in 1 m^3 of sewage:
60 g K_2O
20 g P_2O_5

installation of irrigated fields. We should also mention the relatively high labor costs, which have a particularly high requirement in the agricultural use of sewage[3].

In Massachusetts, the leading state in the field of city sewage systems, and in neighboring southern states, a number of cities established irrigated fields in the second half of the last century[4]. In most cases these arrangements were liquidated after 10 or 20 years.

Completely different circumstances are prevalent in the western United States. Summer heat and the almost complete lack of precipitation during the vegetative season lead to the use of both pure and sewage water in large amounts for irrigation.

Different geographic conditions have affected the distribution of the use of sewage for agricultural needs, and the majority of irrigated fields in the United States are located in the western part of this country[5].

Irrigated fields give the best results under conditions of the arid southern climate. At this time the valuable content of fertilizer compounds contained in sewage is relegated to the background, and the water is used carefully. In arid centers in the United States, already purified sewage is used in some cities to irrigate agricultural crops.

The excellent effects of using the sewage from Milan to irrigate meadows in the Vettabia, where the sewage is diluted with river water, are well known. In several southern cities of the USSR considerably better harvests are obtained by irrigating grapes and agricultural and garden crops. The irrigated fields of Odessa, existing since 1888, and those of Kiev, existing since 1894, give good results. In 1948 work was begun to construct irrigated fields in Shkoda Gora near Odessa. These fields will contain 1500 ha of black soil. The sewage of Dnepropetrovsk will be used to irrigate light fields with a surface of 5000 ha situated on the left bank of the Dnepr.

The agricultural use of sewage has favorable conditions in Poland, which contains about 70% light, permeable soils, and particularly in the arid region of Bydgoszcd, Lodz and Poznan, where the mean annual amount of precipitation is within the limits of 450 - 500 mm or slightly more.

A severe climate makes it extremely difficult or even impossible to use sewage agriculturally. The agricultural cooperative of the Uchtom District makes use of sewage from the city of Moscow to irrigate vegetable crops

[3]Additional work in connection with increasing crops, difficulties in drying grass, the need to constantly cultivate the soil and control of weeds.

[4]Among others, Concord, Worcester (Massachusetts), Wayne (Pennsylvania), and East Orange (New Jersey).

[5]In the United States 267 small towns and villages agriculturally use irrigated fields to purify water.

(Szniolis Al., "The Development of Sanitary Engineering and Hygiene in the United States of North America", Gas, Woda i Techn. San., 1948, No. 1, p. 1.

exclusively in the vegetative season, while during the 5 months of Winter this water is purified either on soil filters or by using the artificial biological method. This type of double arrangement for purification considerably raises plant costs, but can be profitable in localities with white soil and insufficient amounts of precipitation.

Table 1
Number of Cities in England, Germany and Poland Purifying Sewage on Irrigated Fields

Country	1895 .	1967	1930	1949
England	45	8	less than 8 cities	?
Germany (within territorial boundaries of 1946)	5	16	37	more than 40 cities
Poland (within territorial boundaries of 1946)	3	7	23	31 cities[6)]

An important factor in spreading the agricultural use of sewage is the formation of the terrain. Distance from the city and the difference in height play a decisive role. Annual costs of transmission, with a need to pump sewage to a considerable distance and height can take shape on a level which rules out the profitability of agricultural use of this water.

Table 2
Heat and Precipitation in the United States

Locality	State	Mean Temperature in July and August	Mean Annual Precipitation
Fresno	California	+ 28	238.5 mm
Phoenix	Arizona	32	195
Yuma	"	32.5	70

The length of the pumping conduits to the closest irrigated fields from

[6]Of the 31 cities in Poland with irrigated fields, 17 arrangements are active, and 14 are inactive as a result of destruction by military activity.

Berlin amounts to 30 km. These fields, embracing 10,708 ha of irrigated land, cannot be enlarged any more, because the distance of 30 km is considered the limiting one under these conditions.

In 1927 sewage purification on the irrigated fields of the city of Magdeburg was halted. The irrigated fields, established in 1895, were located 12 km from the city and included 540 ha of area. The field area was 40 m above the level of the sewage pumping station tank. The transmission costs which were too high gave decided impetus to the abandonment of the use of these irrigated fields[7]. However, even in subsequent years, water has been pumped to the fields for the purpose of irrigating garden crops in the vegetative season.

The profitability of the agricultural use of sewage takes a completely different form when the terrain formation permits this water to be conducted to the irrigated fields by gravity. The initial costs of the pumping station, the annual pumping costs, and interest on the capital and amortization of the equipment of this station do not even come into the picture. The possibility of conducting sewage, without the need to pump it, to irrigated fields must be considered as a particularly favorable factor in the agricultural use of this water, and in purification plants the possibility of using gravity to supply irrigated fields with sewage should be taken into consideration.

Only four cities in P[illegible]d conduct their sewage to fields (meadows) for irrigation by gravity [illegible]szn, Lodz, Rawicz and Strzelce Opolske. In Germany the cities of C[illegible]rmstadt, Dortmund, Freiburg in Lower Saxony, Quedlinburg and Stadti[illegible]ply their irrigated fields with sewage without pumping.

The examples of the unfavorable effect of geographic factors (climate, soil, terrain formation) on the use of irrigated fields that were mentioned and the far-reaching elimination of these fields in England do not include cases of elimination brought about for other reasons.

Overburdening irrigated fields with the simultaneous impossibility of increasing their area, and taking the terrain of these fields over through the building-up of a city or the construction of new parks, stadiums, etc., and for land and water communication equipment, can necessitate the use of methods of purification, most often the artificial biological method.

Only a single case of the planned elimination of irrigated fields can be noted in Poland. In 1936 Sopot stopped using its irrigated fields. These fields, existing since 1897 near Jelitek at a distance of not quite 1 km alongside a race course, originally included meadows with an area of 14 ha and were then increased to 29.65 ha. In view of the expansion of the

[7] Since 1927 the sewage has been given only a mechanical purification treatment and discharged into the Elbe.

city, and primarily to completely separate the city health resort from the dirty water and from the open purification area of the irrigated fields, were planned for phase-out. Since 1936 the sewage has been conducted to the "na Zaspie" (On the Snowdrift) purification plant of the city of Gdansk, 4 km from the city. This is an activated sludge plant.